

WHAT IS CLAIMED IS:

1. An impact absorbing type steering column  
apparatus provided with collision energy absorbing  
means for absorbing an energy of a secondary  
5 collision of an occupant upon a collision of a  
vehicle, said apparatus comprising:

energy absorption quantity adjusting means for  
changing a secondary collision energy absorption  
quantity of said collision energy absorbing means;  
10 at least one sensor for detecting a condition of  
the occupant or the vehicle; and

electric control means for controlling a drive  
of said energy absorption quantity adjusting means on  
the basis of a result of detection by said sensor.

15

2. An impact absorbing type steering column  
apparatus according to claim 1, further comprising a  
collapsible column rotatably supporting a steering  
shaft and getting collapsed with a predetermined  
20 collapse load,

wherein said collapsible column includes an  
outer column, an inner column entering said outer  
column when said collapsible column gets collapsed,  
and

25 said collision energy absorbing means has a  
plurality of metal balls interposed between said  
outer column and said inner column and forming

plastic grooves in at least one of said outer column and said inner column when said collapsible column gets collapsed.

5           3. An impact absorbing type steering column apparatus according to claim 2, wherein the plurality of metal balls are constructed of a first group of metal balls retained in first metal ball retaining means and a second group of metal balls retaining in  
10 second metal ball retaining means, and

          said energy absorption quantity adjusting means is provided with retaining means rotational driving means for rotating at least one of the first group of metal balls and the second group of metal balls in  
15 order to make a part or the whole of angular phases of the metal balls in the first metal ball group with respect to said collapsible column coincident with or different from the metal balls in the second metal ball group.

20

          4. An impact absorbing type steering column apparatus according to claim 1, further comprising:

          a steering column for rotatably supporting said steering shaft; and

25           a car body sided bracket, fixed to the car body, for supporting said steering column and allowing said steering column to get released therefrom when an

impact load equal to or larger than a predetermined value acts,

wherein said collision energy absorbing means is provided between said steering column and said car body sided bracket, and drawing means causes a plastic deformation of an energy absorbing member composed of a metal plate or a metal wire with a shift of said steering column.

10           5. An impact absorbing type steering column apparatus according to claim 4, wherein said drawing means is a metal rod or a metal ball, and

              said energy absorption quantity adjusting means changes at least one of a plastically deformed portion and a plastic deformation quantity of said energy absorbing member by said drawing means.

              6. An impact absorbing type steering column apparatus according to claim 1, further comprising:

20           a steering column for rotatably supporting said steering shaft; and

              a car body sided bracket, fixed to the car body, for supporting said steering column and allowing said steering column to get released therefrom when an

25           impact load equal to or larger than a predetermined value acts,

              wherein said collision energy absorbing means is

provided between said steering column and said car  
body sided bracket, and causes a fracture, or a  
bending deformation and the fracture of said energy  
absorbing member composed of the metal plate with a  
5 shift of said steering column.

7. An impact absorbing type steering column  
apparatus comprising:

a collapsible column rotatably supporting a  
10 steering shaft and getting collapsed with a  
predetermined collapse load,

said collapsible column including:

an outer column;

an inner column entering said outer column when  
15 said collapsible column gets collapsed; and

a plurality of metal balls interposed between  
said outer column and said inner column and forming  
plastic grooves in at least one of said outer column  
and said inner column in order to absorb a collision  
20 energy when said collapsible column gets collapsed,

wherein said steering column apparatus is  
provided with energy absorption quantity adjusting  
means for changing an absorption quantity of the  
collision energy.

25

8. An impact absorbing type steering column  
apparatus according to claim 7, wherein the plurality

of metal balls are constructed of a first group of metal balls retained in first metal ball retaining means and a second group of metal balls retaining in second metal ball retaining means, and

5           said energy absorption quantity adjusting means is provided with retaining means rotational driving means for rotating at least one of the first group of metal balls and the second group of metal balls in order to make a part or the whole of angular phases  
10 of the metal balls in the first metal ball group with respect to said collapsible column coincident with or different from the metal balls in the second metal ball group.

15           9. An impact absorbing type steering column apparatus comprising:

          a steering column for rotatably supporting said steering shaft;

          a car body sided bracket, fixed to the car body,  
20 for supporting said steering column and allowing said steering column to get released therefrom when an impact load equal to or larger than a predetermined value acts; and

          collision energy absorbing means provided  
25 between said steering column and said car body sided bracket, for absorbing an energy of a secondary collision of an occupant by causing a plastic

deformation of an energy absorbing member composed of a metal plate or a metal wire by use of drawing means with a shift of said steering column,

wherein said steering column apparatus is  
5 provided with energy absorption quantity adjusting means for changing an absorption quantity of the collision energy.

10 10. An impact absorbing type steering column apparatus according to claim 9, wherein said drawing means is a metal rod or a metal ball, and

said energy absorption quantity adjusting means changes at least one of a plastically deformed portion and a plastic deformation quantity of said  
15 energy absorbing member by said drawing means.

11. An impact absorbing type steering column apparatus comprising:

20 a steering column for rotatably supporting said steering shaft;

a car body sided bracket, fixed to the car body, for supporting said steering column and allowing said steering column to get released therefrom when an impact load equal to or larger than a predetermined  
25 value acts; and

collision energy absorbing means provided between said steering column and said car body sided

bracket, for absorbing an energy of a secondary collision of an occupant by causing a fracture, or a bending deformation and the fracture of said energy absorbing member composed of the metal plate with a shift of said steering column,

wherein said steering column apparatus is provided with energy absorption quantity adjusting means for changing an absorption quantity of the collision energy.

10

12. An impact absorbing type steering column apparatus according to any one of claims 1 through 11, wherein an electromagnetic actuator is a driving source of said energy absorption quantity adjusting means.

15

13. An impact absorbing type steering column apparatus according to any one of claims 1 through 11, wherein an electric motor is a driving source of said energy absorption quantity adjusting means.

20

14. An impact absorbing type steering column apparatus according to any one of claims 1 through 11, wherein said energy absorption quantity adjusting means changes an absorption quantity of the secondary collision energy by said energy absorbing means at least three or more stages.

25

15. An impact absorbing type steering column apparatus according to any one of claims 1, 4, 5, 9 and 10, wherein said energy absorption quantity  
5 adjusting means changes an absorption quantity of the secondary collision energy by said energy absorbing means in an infinitely variable manner.

16. An impact absorbing type steering column  
10 apparatus according to any one of claims 1 through 11, wherein said energy absorption quantity adjusting means changes an absorption quantity of the secondary collision energy by said energy absorbing means in two or more modes, and  
15 energy absorption loads are substantially fixed with respect to a progress of a collapse stroke after points of inflections of energy absorption characteristics in the two or more modes.

20 17. An impact absorbing type steering column apparatus according to any one of claims 1 through 11, wherein said energy absorption quantity adjusting means changes an absorption quantity of the secondary collision energy by said energy absorbing means in  
25 two or more modes, and  
energy absorption loads gradually increase with respect to a progress of a collapse stroke after



points of inflections of energy absorption characteristics in the two or more modes.

18. An impact absorbing type steering column  
5 apparatus according to any one of claims 1 through 11,  
wherein two types of energy absorption characteristics are exhibited, and

a large load characteristic has a collapse load that is twice or greater as large as that of a small  
10 load characteristic after points of deflections of these two types of energy absorption characteristics.

19. An impact absorbing type steering column apparatus according to any one of claims 1 through 11,  
15 wherein two or more types of energy absorption characteristics are exhibited, and these two or more types of energy absorption characteristics delay a rise timing of absorbing the energy.

20 20. An impact absorbing type steering column apparatus comprising:

a collapsible column rotatably supporting a steering shaft and getting collapsed with a predetermined collapse load,

25 said collapsible column including:

an outer column;

an inner column entering said outer column when

said collapsible column gets collapsed; and

5 a plurality of metal balls interposed between  
said outer column and said inner column and forming  
plastic grooves in at least one of said outer column  
and said inner column in order to absorb a collision  
energy when said collapsible column gets collapsed,

10 wherein said steering column apparatus is  
provided with a plurality of metal ball retainers for  
retaining the metal balls in phases different from  
each other, and retainer separating means for  
separating at least of one of said metal ball  
retainers from said car body sided member in order to  
reduce the number of plastic grooves formed by the  
metal balls when said collapsible column gets  
15 collapsed.

20 21. An impact absorbing type steering column  
apparatus according to claim 20, wherein said  
retainer separating means is an electrically driven  
actuator.

25 22. An impact absorbing type steering column  
apparatus according to claim 21, wherein said  
electrically driven actuator separates said metal  
ball retainer from said car body sided member only  
when being charged with electricity.

23. An impact absorbing type steering column apparatus comprising:

collision energy absorbing means for absorbing an energy of a secondary collision energy of an  
5 occupant upon a collision of a vehicle; and

energy absorption quantity adjusting means for changing an absorption quantity with which said collision energy absorbing means absorbs the secondary collision energy,

10 wherein an electromagnetic actuator is a driving source of said energy absorption quantity adjusting means, and

a plunger of said electromagnetic actuator is adsorptively held in a predetermined position by a  
15 permanent magnet.

24. An impact absorbing type steering column apparatus according to claim 23, wherein said collision energy absorbing means is provided between  
20 said steering column and said car body sided bracket and causes a plastic deformation of an energy absorbing member composed of a metal plate or a metal wire by use of drawing means with a shift of said steering column.

25

25. An impact absorbing type steering column apparatus according to claim 23, wherein said drawing

means is a metal rod or a metal ball, and

5        said energy absorption quantity adjusting means  
changes at least one of a plastically deformed  
portion and a plastic deformation quantity of said  
energy absorbing member by said drawing means.

26. An electric power steering apparatus including an impact absorbing steering column apparatus provided with a collision energy absorbing device which absorbs energy of a secondary collision of an occupant upon a collision of a vehicle, said impact absorbing steering column apparatus comprising:

an energy absorption quantity adjusting device which changes a secondary collision energy absorption quantity of said collision energy absorbing device;

at least one sensor which detects a condition of the occupant or the vehicle; and

an electric control device which controls a drive of said energy absorption quantity adjusting device based on a result of detection by said sensor.

27. An electric power steering apparatus including an impact absorbing steering column apparatus provided with a collision energy absorbing device which absorbs energy of a secondary collision of an occupant upon a collision of a vehicle, said impact absorbing steering column apparatus comprising:

an energy absorption quantity adjusting device which changes a secondary collision energy absorption quantity of said collision energy absorbing device;

at least one sensor which detects a condition of the occupant or the vehicle; and

an electric control device which controls a drive of said energy absorption quantity adjusting device based on a result of detection by said sensor;

wherein said energy absorption quantity adjusting device is operative to change the absorption quantity of the secondary collision energy by said energy absorbing device among two or more stages, and

wherein energy absorption loads are substantially fixed with respect to progress of a collapse stroke after points of inflection of energy absorbing characteristics in said two or more stages.

28. An electric power steering apparatus including an impact absorbing steering column apparatus provided with a collision energy absorbing device which absorbs energy of a secondary collision of an occupant upon a collision of a vehicle, said impact absorbing steering column apparatus comprising:

an energy absorption quantity adjusting device which changes a secondary collision energy absorption quantity of said collision energy absorbing device;

at least one sensor which detects a condition of the occupant or the vehicle; and

an electric control device which controls a drive of said energy absorption quantity adjusting device based on a result of detection by said sensor;

wherein said energy absorption quantity adjusting device is operative to change the absorption quantity of the secondary collision energy by said energy absorbing device among two or more stages, and

wherein energy absorption loads are gradually increased with respect to progress of a collapse stroke after points of inflection of energy absorbing characteristics in said two or more stages.

29. An electric power steering apparatus according to claim 28,

wherein two energy absorption characteristics are exhibited, and

a large load characteristic has a collapse load that is at least twice as large as that of a small load characteristic after points of inflection of the two energy absorption characteristics.

30. An electric power steering apparatus including an impact absorbing steering column apparatus provided with a collision energy absorbing device which absorbs energy of a secondary collision of an occupant upon a collision of a vehicle, said impact absorbing steering column apparatus comprising:

an energy absorption quantity adjusting device which changes a secondary collision energy absorption quantity of said collision energy absorbing device;

at least one sensor which detects a condition of the occupant or the vehicle; and

an electric control device which controls a drive of said energy absorption quantity adjusting device based on a result of detection by said sensor;

wherein said impact absorbing steering column apparatus has a plurality of energy absorption characteristics; and

said energy absorption characteristics delay a rise timing of absorbing the energy.

31. An electric power steering apparatus, comprising:

a collapsible column rotatably supporting a steering shaft and being collapsible with a predetermined collapse load,

said collapsible column including:



an upper column;

a lower column in which the upper column is partially fitted and into which the upper column is displaced when said collapsible column is collapsed,

a collision energy absorbing device provided between the upper column and the lower column to absorb energy of a secondary collision of an occupant upon a collision of a vehicle,

at least one sensor which detects a condition of the occupant or the vehicle,

an electric control device which controls a drive of said energy absorption quantity adjusting device based on a result of detection by said sensor;

wherein said apparatus has a plurality of energy absorption characteristics; and

an electric power assisting unit is fixedly provided to said lower column.

32. An electric power steering apparatus according to claim 31,

wherein said energy absorption quantity adjusting device is operative to change the absorption quantity of the secondary collision energy by said energy absorbing device among two or more stages, and

energy absorption loads are substantially fixed with respect to progress of a collapse stroke after points of inflection of energy absorbing characteristics in said two or more stages.

33. An electric power steering apparatus according to claim 31,

wherein said energy absorption quantity adjusting device is operative to change the absorption quantity of the secondary collision energy by said energy absorbing device among two or more stages, and

energy absorption loads are gradually increased with respect to progress of a collapse stroke after points of inflection of energy absorbing characteristics in said two or more stages.

34. An electric power steering apparatus according to claim 31,

wherein two energy absorption characteristics are exhibited, and

a large load characteristic has a collapse load that is at least twice as large as that of a small load characteristic after points of inflection of the two energy absorption characteristics.

35. An electric power steering apparatus according to claim 31, further comprising:

an electric control device which controls a drive of said energy absorption quantity adjusting device based on a result of detection by said sensor;

wherein said apparatus has a plurality of energy absorption characteristics; and

an electric power assisting unit is fixedly provided to said lower column.